Studying the mechanism and selectivity of surface blocking atomic layer etching

Short Description: Diketones can be utilised for atomic layer etching (ALE) of many metals and oxides. Understanding of the mechanism by which this process occurs and the selectivity of the ALE process between different thin films is currently lacking.

Background: Atomic layer Etching is set to become one of the key processes for further downscaling of integrated circuits (IC) allowing for the continuation of Moore’s Law. First reported in 1988 ALE has witnessed a large increase in number of publications per year due to shrinking critical dimensions within ICs. To create these smaller critical features on a chip more accurate etch techniques are required. ALE is ideal for these etch processes due to its high level of etch control, smoothing effect and selectivity to the desired etched material.

The focus of this project is on characterizing an emerging isotropic ALE mechanism called surface blocking ALE which utilize diketone species, fig1b. Here the first half-cycle spontaneous etches the film but eventually the surface is poisoned and etching stops. The surface is then cleaned with either a O_2 or H_2 plasma and the processes can begin again. This process differs from the more common process of modification followed by removal seen in most ALE literature, and thus is an interesting mechanism to explore. Moreover, selectivity in the ALE process can be achieved by investigating which materials the diketone species absorb onto and create volatile species with.

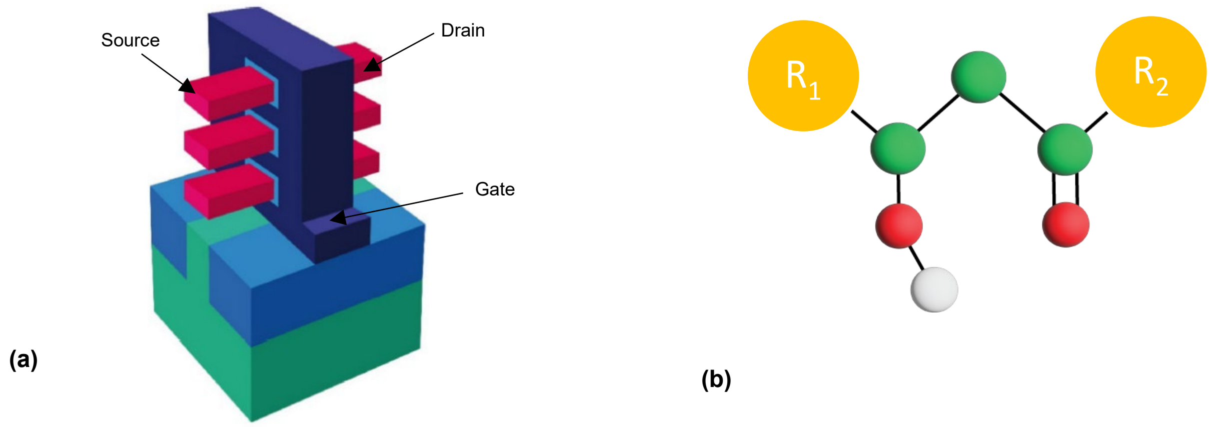

Fig 1: (a) Gate-all-around FET device that will require isotropic ALE to define the source/drain nanowires, (b) Typical structure for a diketone species, there are many different types where $R_{1,2}$ can for example be CH_3, CF_3, $C(CH_3)_3$ etc..

Project: In this project the mechanism by which diketone species etch thin films will be investigated. This will rely on a variety of different measurement techniques. The primary focus will be using fourier transform infrared spectroscopy to investigate how the diketone species bind to the surface. Initially the focus will be on the mechanism for a specific film, and once this is understood the selectivity of the process to other layers will be tested. This project also has the option to utilize density functional theory simulations to model the binding configurations.

Location & Supervision: Project will be mostly experimental work performed in the main lab of the PMP group, with some work being conducted in the cleanroom in spectrum. The daily supervisor will be Nick Chittock & Adrie Mackus, you will work in the Plasma and Materials Processing (PMP) group lead by prof.dr.ir Erwin Kessels.

If interested please contact:

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